A34737-PCT-USA
10/018114
JC13 Rec'd PCT/PTO 14 DEC 2001

GR 00 P 8524 P

Description

Electrical steering propeller having a small installed height

The invention relates to an electrical steering propeller having a small installed height for a seagoing high-speed ship, having a polyphase electric motor which is mounted under the stern of the ship via a shaft which can rotate and preferably has two parts in a gondola-like housing, and can be supplied with electrical drive power via a slipring arrangement, and can be rotated via drive motors.

The prospectus from Siemens and Schottel, entitled "The SSP Propulsor", No. 159U559 04982, April 1998, discloses a steering propeller which can be rotated, in which the sliprings for transmission of the electrical drive power are arranged, in the same way as the hydraulic drive motors for the rotary movement and their hydraulic pumps, in a drive machine room (Propulsor 500 m) above the steering propeller. The cables are supplied to the sliprings from above.

The object of the invention is to refine the known drive such that, in particular for roro ships, more space is obtained in the stern of the ship. In roro ships, by way of example, it is intended to be possible to construct a continuous internal car deck without the stern door for the car deck, and the car deck itself, having to be raised. In this case, as before, adequate capabilities for repair and maintenance should be provided. In this case, it is intended to be possible to design the conditions downstream from the stern to optimize the drag, taking account of the flow conditions resulting from the use of steering propellers.

The object is achieved in that the steering propeller is mounted in the stern of the ship via a flat collar bearing in the vicinity of the outer skin, in particular above the waterline, with the slipring arrangement being

accommodated in the upper part of the shaft at the level of the annular bearing, and with the drive motors for the rotary movement being physically small and being arranged at least partially in the interior of the collar bearing. This results in the small installed arrangement, desired according to the invention, for the electrical steering propeller. Admittedly, at first, it appears to be impossible to accommodate the sliprings and the drive motors for the rotary movement etc. in the upper part of the shaft with its "rotating bearing" constriction, so that it is still possible to produce a passage downward. However, the invention is feasible by optimizing the sizes of all the parts and by largely dispensing with horizontally running struts. This makes it possible to move the drive motors for the rotary movement to the area under the slipring arrangement.

The flat collar bearing can be arranged both above the waterline and, alternatively, below the waterline. In the case of an arrangement below the waterline, it is advantageously kept at an increased pressure. The arrangement disclosed in Canadian Patent Specification 1.311.657, with the shaft entering the ship below the waterline and an internal extension of the shaft to above the waterline, is considerably less advantageous. This can result in seawater entering the interior of the bearing.

If the shaft it mounted in a large-diameter collar bearing above the waterline, with the bearing diameter being approximately equal to or greater than the winding length of the electric motor, this results, especially when, as advantageously proposed, the collar bearing also has a large internal diameter, in the upper part of the shaft of

the steering propeller being so roomy that the slipring arrangement, whose size has

been optimized, and the rotating motors can be accommodated completely inside it. It is thus highly advantageously possible to dispense with a separate machine room above the steering propeller, and installed height can be saved. The collar bearing can be arranged directly under the car deck.

In this case, it is advantageous for the shaft to have a shaft upper part which is arranged above the ship's waterline, and which is largely arranged recessed in the ship's stern. This very advantageously results in all the major parts of the rotating drive being arranged in a protected manner outside the water flowing around the hull. If the height of the shaft lower part in this case corresponds approximately to the gondola diameter, this results in a very physically small drive overall, since the high-speed double propeller intended for use makes it possible to choose relatively small propeller diameters. This advantageously allows a drive to be produced for shallow-draft ships, configured according to the invention.

A further refinement of the invention provides for the drive motors for the rotary movement to be in the form of flat hydraulic radial piston motors. This results in a particularly advantageous configuration of the rotating motors, with small dimensions and a large torque.

The invention advantageously provides for the possibility of connecting the shaft to the ship's hull via an intermediate covering part immediately under the lowermost cargo deck in the stern area, for example the car deck in the case of roro ships. Such a small intermediate covering part, which may also be in the form of an annular disk, advantageously results in the capability to install the electrical steering propeller such that it is both particularly stable and is physically small. The intermediate covering part can be arranged in the stern area both via mounting elements, for example boxes, and directly, for example by fitting it on the double bottom.

Particularly in the case of roro ships, it is in this case advantageous if the shaft is mounted under a steering propeller sealing cover in the ship's stern, with the sealing cover advantageously being a component of the car deck when the ship is in the form of a roro ship. This results in particularly good utilization of the physical height available in the stern of the

ship, which allows vehicles to be driven directly onto the inner car deck via the stern door. This allows the car deck to be used over the full length of the ship, thus resulting in previously impossibly good space utilization for the main car deck. Full utilization of the weather-deck area is likewise ensured, in which case the capstan drives etc. can advantageously be arranged under the weather-deck in order to enlarge the usable area.

A refinement of the invention provides for the sealing cover to have access openings to individual appliances in the steering propeller, for example to the slipring arrangement, to the drive motors for the rotary movement and to other essential functional elements. Thus, advantageously, there is no need to remove the sealing cover in the car deck for servicing work and minor repairs, since the corresponding appliances can instead be accessed via access openings like manholes.

The invention in this case advantageously provides for the upper part of the steering propeller to be sealed in a fire-resistant manner from the lowermost deck in the stern area. This advantageously makes it possible to comply with the safety requirements for roro or ropax ships, without needing to modify the advantageous configuration, which requires a minimal installed height, of the electrical steering propeller.

The invention furthermore provides for the electrical steering propeller that the sliprings for supplying power to and monitoring the motor are at least partially in the form of concentric sliprings. This results in a small physical shape for the power supply and signal transmission components. For electric motors having more

than 3 phases, for example for 6-phase or 12-phase electric motors, as well as for split electric

motors, the invention in this case provides in particular for the power supply sliprings to be designed to have only 3 phases and for a junction to a motor winding system having more than 3 phases

to be made behind the slipring arrangement via power semiconductors, which form a local converter and are arranged in the shaft. It is thus also possible to supply power to polyphase or split electric motors with a physically small, relatively simple slipring body. This considerably simplifies the construction, and considerably reduces the physical height of the slipring arrangement. Polyphase winding systems can thus be supplied with electrical power in a controlled, advantageous manner. The power semiconductors can highly advantageously by well cooled via heat dissipation elements which are connected to the shaft casing, which is well cooled by the seawater flowing around it.

The cables for power transmission are advantageously routed from the side to the slipring arrangement of the shaft. This admittedly requires a separate connecting element on the slipring arrangement. The additional costs incurred as a result of this are, however, more than compensated for by the gain in space. The connecting element can advantageously run between the vehicle lanes on the car deck of a roro ship. This therefore does not detract from the small installed height of the steering propeller.

As a result of the arrangement of the drives for the rotary movement and for the slipring body etc. in the shaft upper part, these must be [lacuna] close to the auxiliary appliances in the shaft, for example the bilge pumps and oil pumps etc. If required, power semiconductors are also located in this area, since the lower shaft part is designed to be narrow to assist the flow (also acting as a rudder). It is impossible to prevent heat accumulations from being formed. This is overcome by

arranging at least one fan in the upper part of the shaft, which allows air to circulate in the

shaft upper part, and if necessary also allows air to be interchanged.

The invention furthermore advantageously provides for the transition from the upper part to the lower part of the shaft to be located at the same level as the outer skin of the ship, preferably entirely above the waterline. The flange between the upper part and lower part

of the ship can thus be removed from the flow around the hull, thus also allowing the shaft to be replaced with the electric motor for repairs, without any need for the ship to be docked. For reliably "dry" replacement, it is sufficient for the ship to be trimmed bow-down.

A further refinement of the invention provides for the motor shaft of the steering propeller to be inclined at an angle matched approximately to the stern profile of the ship. This results in a particularly advantageous downstream flow in the stern area of the ship, which highly advantageously makes use of the flow, accelerated by the propellers, to reduce the stern drag of the ship. The steering propeller according to the invention can then be arranged right at the stern without any disadvantageous effects on the flow. This advantageous configuration results in the maximum amount of space being gained. Thus, overall, not only does the use of the steering propeller according to the invention, with a small installed height, result in better utilization of the space available in the stern area of the ship's hull, but there is also no deterioration in the flow in the stern area in comparison to conventional steering propellers arranged more deeply under the ship.

The invention will be explained in more detail with reference to the drawings from which, in the same way as from the dependent claims, further details that are essential to the invention will become evident. In detail:

Figure 1 shows a steering propeller according to the invention with its installation that occupies very little space, from the side,

Figure 2 shows a double steering propeller arrangement in the stern area of the ship, from astern,

Figure 3 shows the double steering propeller arrangement illustrated in Figure 2, from above,

Figure 4 shows the shaft upper part, with the cable supply at the side, from the side.

Figure 5 shows the shaft upper part as shown in Figure 4, from above, and

Figure 6 shows a compressed section through a collar bearing arrangement with a particularly small installed height.

Figure 1 shows a roro or ropax application with a very small installed height between the outer skin 6 and the car deck 5. All the components of the electrical steering propeller, with the exception of the shaft 2 and the motor part 1, are fitted into this small installed height.

The following measures are taken, by way of example, in order to achieve the fit described above:

A small intermediate covering part 10, possibly in the form of an annular disk, is inserted between the outer skin 6 and the car deck 5, with the steering propeller being mounted on it. The stationary parts of the collar bearing 7 are arranged above the intermediate covering part 10. A cover 4, which is advantageously sealed in a fire-resistant manner, is installed in the car deck 5, through which the steering propeller unit located underneath is accessible. Various small covers (not shown) which provide easy access to the major functional parts of the steering propeller are inserted into this - large - cover 4. The slipring arrangement 8 and the rotating motors 9 are very largely located in the interior of the collar bearing 7 and in the shaft upper part 3. The collar bearing 7, together with the intermediate covering part 10 (which is physically particularly small here), is advantageously arranged in the stern of the ship, via a box structure 11.

The large cover 4 can be supported directly or indirectly on the intermediate covering part 10, so that the space under the cover 4 has a very small physical height, and the overall installed height is thus optimally low. The bending-resistant power

supply cable can advantageously be routed to the slipring arrangement from the side, so that the cover 4 is smooth and can be mounted directly above the slipring arrangement.

The steering propeller itself is advantageously inclined such that its drive axis runs at a rising angle to the rear. This improves the downstream flow, even if the stern is short. In this case, the separating flange between the upper part of the steering propeller 3 and the shaft may be located approximately at the same level as the outer skin so that, if the steering propeller is arranged relatively far to the stern, and it is physically short, no flange parts need be arranged in the flow around the hull.

The cover 4 is advantageously provided with a fire-resistant seal so that, in the event of a fire in this part of the drive system, there is no risk to the car decks located above it. Conversely, the operation of the drive system is not adversely affected by a fire on the car deck, and the ship can still be propelled.

The low height between the intermediate covering part and the cover is also achieved by using flat radial piston hydraulic motors for the azimuth drive. The medium voltage for the main motor, the low voltage for the auxiliary systems and the signals for control/regulation of the motor are transmitted via the electrical slipring arrangement 8, which is located in the upper part 3 of the shaft and, in particular, has a number of parts. The steering propeller itself can be rotated endlessly through 360°. The sliprings of the slipring arrangement 8 are arranged especially concentrically with respect to one

another, with the signal transmission antennas (which are not shown in

any greater detail) advantageously being located on the outside.

Figure 2 shows the two steering propeller units, annotated 18 and 19. In this embodiment, the intermediate covering part is advantageously located directly on the double bottom 17. The column bearing is mounted, for example, via struts, and the rotating motors are arranged in the same way as the slipring bodies, according to the invention, in the intermediate space 16 underneath the car deck 15. This results in a small physical height for the installation of the steering propellers, which are arranged well astern.

As can be seen from Figure 3, the auxiliary appliances 12 for the azimuth drive, for example the hydraulic pumps and their motors, are likewise located in the intermediate space underneath the car deck. The two steering propellers 13 and 14 are supplied with rotation power via short hydraulic lines. According to the invention, this also advantageously makes it possible to dispense with a separate machine room above the steering propellers 13 and 14.

In Figure 4, 21 denotes a cable connection which is routed at the side, 23 denotes the upper cover on the slipring arrangement, and 22 denotes the upper parts of the drives for the rotary movement. Figure 4 shows a particularly good example of the small installed height which can be achieved.

In Figure 5, 24 denotes the connecting part of the cable connection 29, 27 denotes an entry into the shaft, and 26 denotes a spare cross section. 28 denotes a fan, and 30 a drive for the rotary movement. Since the components shown all also have connecting lines, terminals, mounting elements, flanges etc., it is obvious that optimization was required here, necessitating detailed considerations.

In Figure 6, which shows a physically small collar bearing according to the invention, illustrated partially in the form of a section, 31 denotes the

ship structural part which forms the base for the collar bearing. This may be, for example, an intermediate covering part, a part of the double bottom or an annular part on the outer skin of the ship. 32 denotes, for example, the car deck in the case of a roro ship, or the deckhead on the car deck. 33 denotes a motor for the rotary drive, which is mounted on a support 37. 34 denotes a drive pinion for the rotating ring 35 of the collar bearing. Finally, 36 denotes the shaft of the steering propeller, which is connected directly to the rotating part of the collar bearing. The connecting elements between the individual parts, such as flanges with bolts, welded seams, etc., are not shown, since Figure 6 is an outline illustration of a particularly physically small bearing arrangement. In this case, the drive motors 33 for the rotary movement are even arranged completely inside the shaft.

In the example shown in Figures 2 and 3, the flow reaches the steering propellers 13, 14, 18 and 19 freely. This is important especially for particularly low-vibration operation, although flow guide bodies can also be arranged upstream of the steering propellers, being designed in particular in the form of hooks with the hook tip at the same level as the shafts of the steering propellers. This results in the ship moving straight ahead particularly well, a possible improvement in the propulsion efficiency, and a possible improvement in the downstream flow behavior of the ship's stern. However, in this case, the tendency of the drive system to vibrate must be optimized with respect to the advantages achieved, so that these flow guide bodies are more appropriate for roro ferries, and are less suitable for ropax ferries or for cruise ships.

The optimization is in each case dependent on the ship type, speed and field of use. With appropriate

optimization, all the ship types can advantageously be equipped with flow guide bodies

arranged in front of the steering propellers and having a roughly droplet-shaped cross section. The flow guide bodies admittedly increase the wetted surface area, but their advantages for the ship behavior, the downstream drag and the propulsion efficiency may, however, more than compensate for this disadvantage. It is particularly advantageous to combine them (not shown) with the physically small, possibly short, steering propellers according to the invention, since this allows the additional wetted area to be kept small.